IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

First Named Inventor :	William R. Priedeman, Jr.	
Appln. No.:	10/511,784	Confirmation No.: 4209
Filed :	October 15, 2004	Group Art Unit: 1791
For :	Smoothing Method For Layered Deposition Modeling	Examiner: John L. Goff II
Docket No.:	S697.12-0065	

DECLARATION OF ROBERT L. ZINNIEL UNDER C.F.R. § 1.132

I, Robert L. Zinniel, state:

1. I am a product development engineer at Stratasys, Inc. in the field of production of plastic parts, including rapid prototyping/manufacturing processes and injection molding processes. I am an employee of Stratasys, Inc., the assignee of U.S. Patent Application No. 10,511/784. As a result, I have an interest in the outcome of this patent application.

2. I conducted a porosity test to show that (1) three-dimensional (3D) objects built with a deposition-based layered manufacturing technique, such as with a fused deposition modeling system, are necessarily porous due to the build technique, and (2) the vapor smoothing process taught in U.S. Patent Application No. 10/511,784 (the current patent application) for smoothing the surfaces of the 3D objects also necessarily reduces or eliminates surface porosities of the 3D objects.

3. The porosity experiment initially involved building three identical 3D objects with a fused deposition modeling system from a yellow-colored, acrylonitrile-butadiene-styrene (ABS) thermoplastic copolymer. The 3D objects were built from the same digital model and under the same operating conditions. After being built, each 3D object had striation and stair-step effects due to the build technique, which covered the entire surface of the given 3D object. This is shown in Image 1 in Appendix A-1, which is representative of both 3D objects that were built.

4. One of the 3D objects was then placed in a vapor chamber that contained vapors of a normal-propyl bromide solvent. This exposed the 3D object to the solvent vapors, which softened the ABS material at the object surface and caused the ABS material to reflow to the smooth the entire surface of the 3D object. This is shown in Image 2 in Appendix A-1.

5. Another one of the 3D objects was then hand sanded with 120-grit sandpaper until the exterior surface was smooth. This is shown in Image 3 in Appendix A-2.

6. Each 3D object was then subjected to a porosity test. The non-vapor smoothed 3D object represented a 3D object prior to vapor smoothing and the vapor smoothed 3D object represented the same 3D object after being vapor smoothed. I ran this experiment with separate 3D objects rather than with the same 3D object before and after vapor smoothing to reduce the burden of repeating the porosity test. The results of the porosity test would be the same in either situation.

7. Image 4 in Appendix A-3 shows the equipment used for the porosity test. The non-vapor smoothed 3D object was placed on the air seal base block such that the flange portion of the 3D object rested on the base block and the dome portion of the 3D object extended over the center opening of the base block. The air seal top ring was then place over the flange portion of the 3D object such that the dome portion of the 3D object extended through the center opening of the top ring. The top ring was then tightened against the flange portion of the 3D object and the base block with four screw-type fasteners. This created an air tight seal between the top plate, the flange portion of the 3D object, and the base block.

8. The bottom end of the base block was connected with an air tight seal to the air tube. The air tube was also connected to the pressurized air line, which was controlled by a pressure gauge to adjust the pressure of air flowing into the base block. The mounted 3D object was then immersed in the container of water such that the 3D object was completely submerged in the water. The air line was then opened to a pressure of about 6 psi to introduce pressurized air to the mounted 3D object.

9. Image 5 in Appendix A-4 is a still photograph of the mounted and submerged 3D object after the pressurized air was introduced. The pressurized air flowed through the 3D object to produce a substantial amount of air bubbles in the water. The air bubbles were due to air passing through pores in the 3D object. If any bubbles were formed due to air leaking through the air seals between the 3D object, the top ring, and the base block, they would have accounted for a very small amount of the air bubbles shown in Image 5.

10. The pores in the 3D object were due to the deposition-based layered manufacturing technique used to build the 3D object. 3D objects built with a deposition-based layered manufacturing technique, such as with a fused deposition modeling system, are necessarily porous due to the build technique. The pores are created to provide a cushion in the build parameters when depositing the ABS material to maintain the dimensional accuracy of the 3D object. This is discussed in U.S. Patent No. 5,653,925, issued in August 1997, and is recognized by people skilled in the art of rapid prototyping/manufacturing processes.

11. I then ran the same test on the vapor smoothed 3D object. Image 6 in Appendix A-4 is a still photograph of the mounted and submerged 3D object after the pressurized air was introduced. In this case, the pressurized air did not flow through the 3D object and only a single stream of air bubbles slowing escaped, probably due to air leaking through the air seals between the 3D object, the top ring, and the base block. This is because, in addition to smoothing the 3D object surface, the vapor smoothing process also eliminated the surface porosity of the 3D object. This sealing effect at the surface of the 3D object would be recognized by people skilled in the art of rapid prototyping/manufacturing processes based on the teachings in U.S. Patent Application No. 10/511,784 (the current patent application).

12. I then ran the same test on the hand sanded 3D object, but with an air line pressure of about 5 psi. Image 7 in Appendix A-5 is a still photograph of the mounted and submerged 3D object after the pressurized air was introduced. In this case, the pressurized air also flowed through the 3D object to produce a substantial amount of air bubbles in the water. The air bubbles were due to air passing through pores in the 3D object. So, while the hand sanding did smooth out the exterior surface of the 3D object, it did not reduce or eliminate the surface porosity.

13. I declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statement were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 18 U.S.C. § 1001, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Robert L. Zinniel

Date: 11/16/09

Appendix A-1

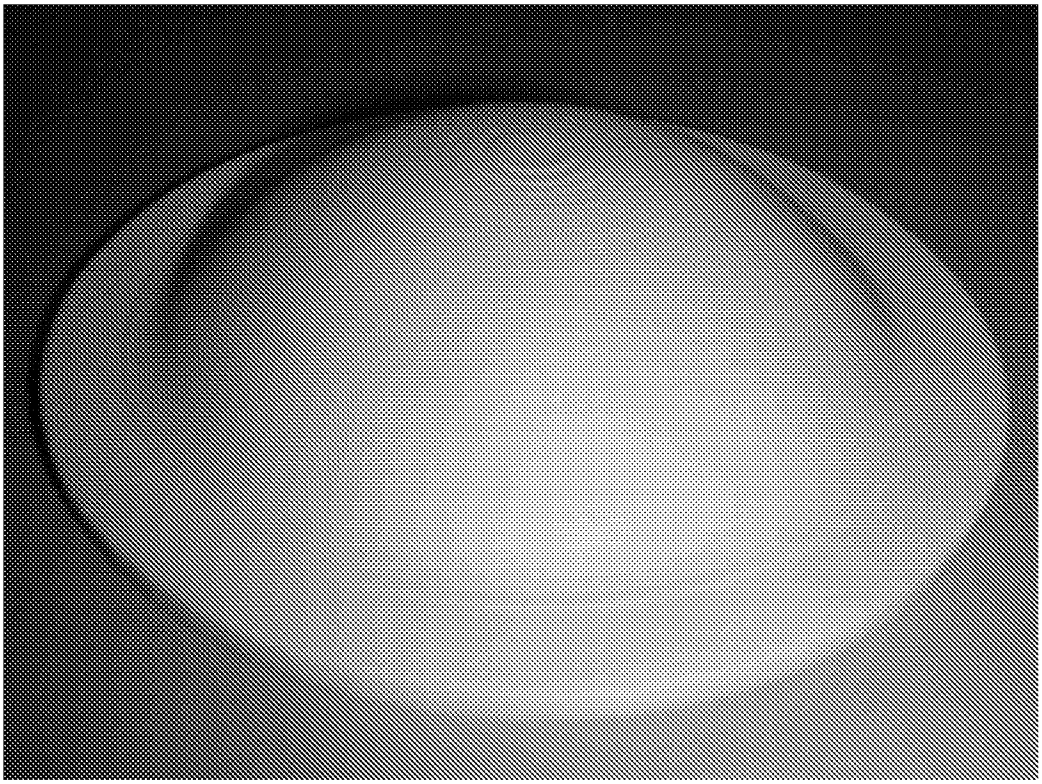
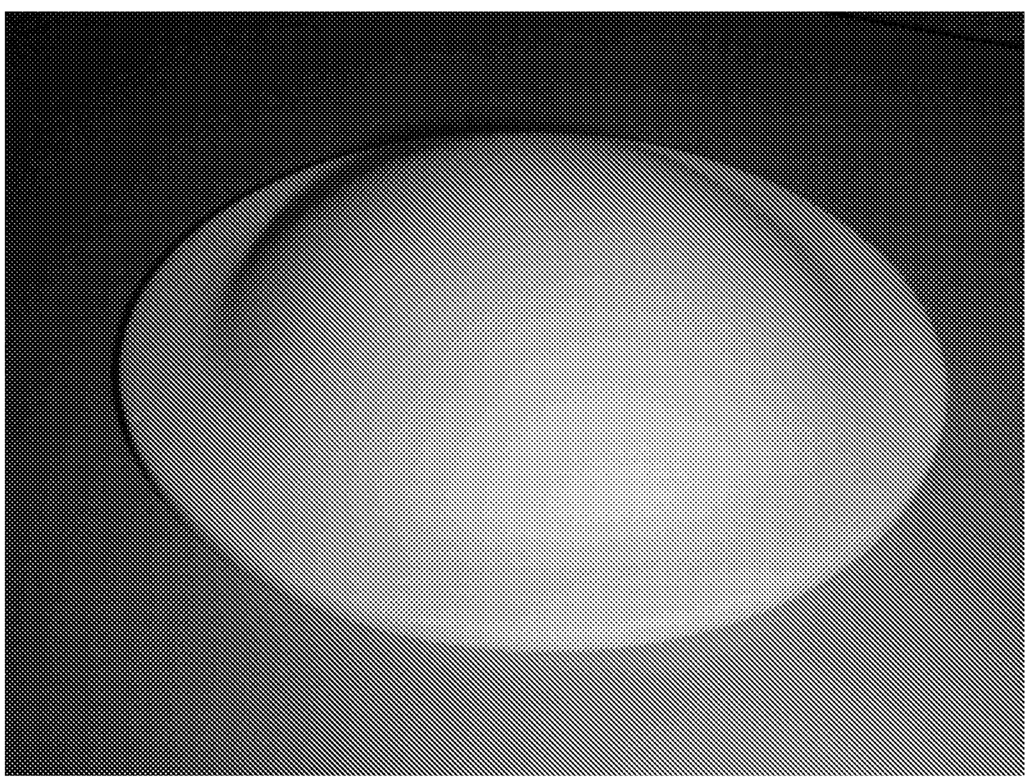


Image 1

Image 2



Appendix A-2

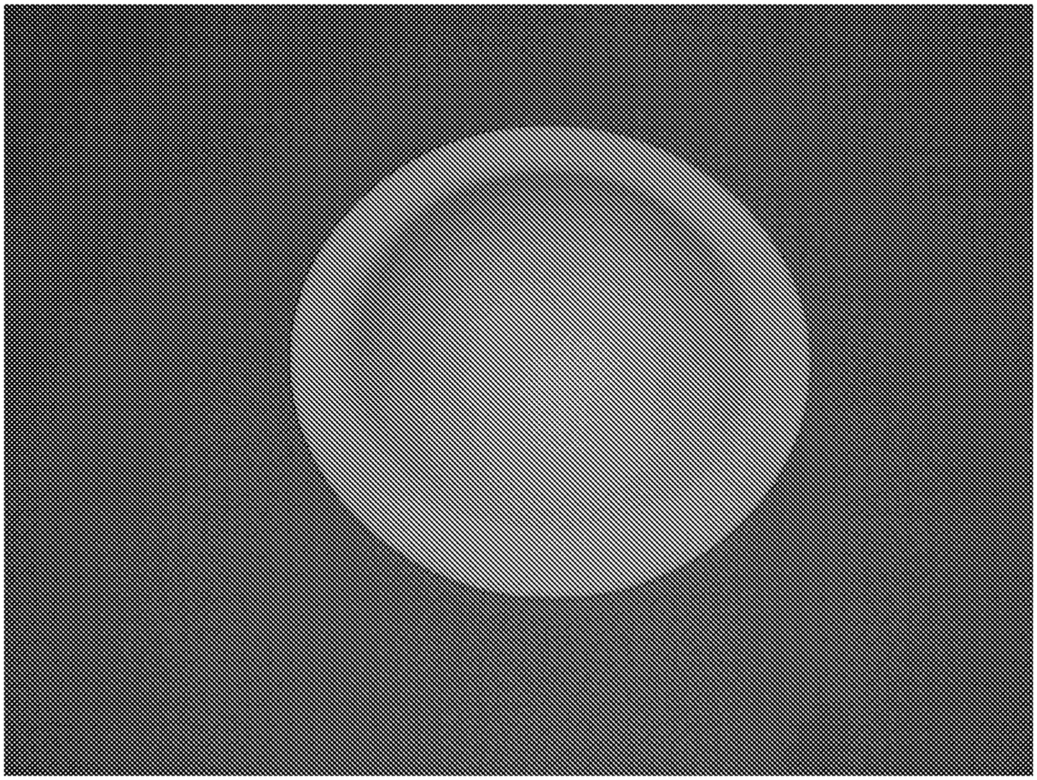


Image 3

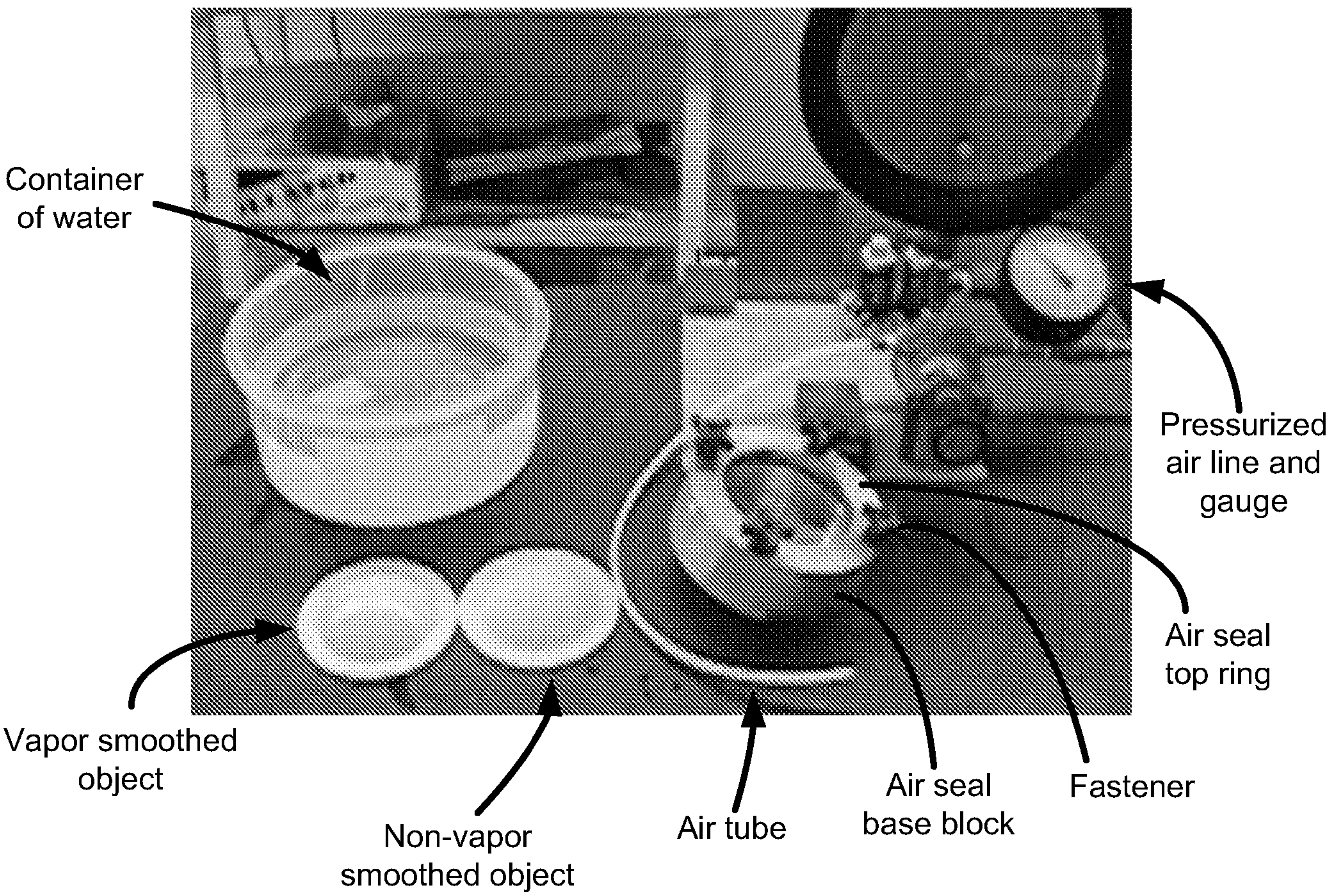

Container of water
Pressurized air line and gauge
Air seal top ring
Vapor smoothed object
Non-vapor smoothed object
Air tube
Air seal base block
Fastener

Image 4

Appendix A-4

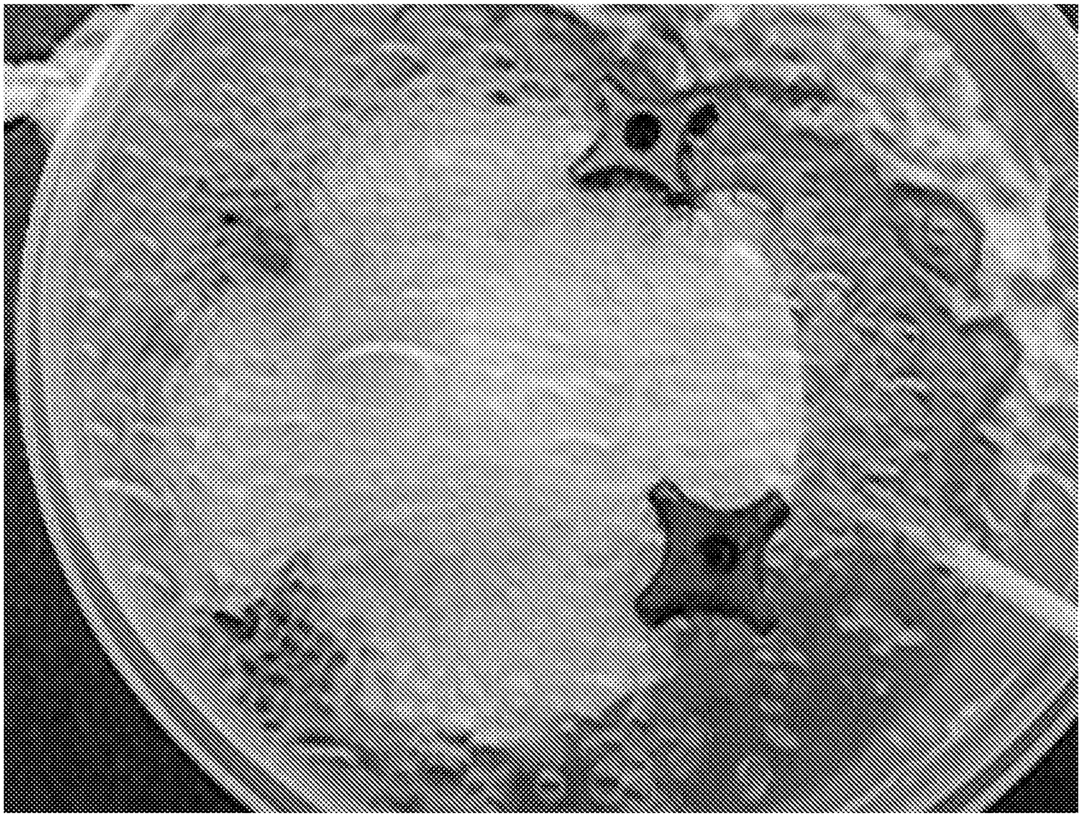


Image 5

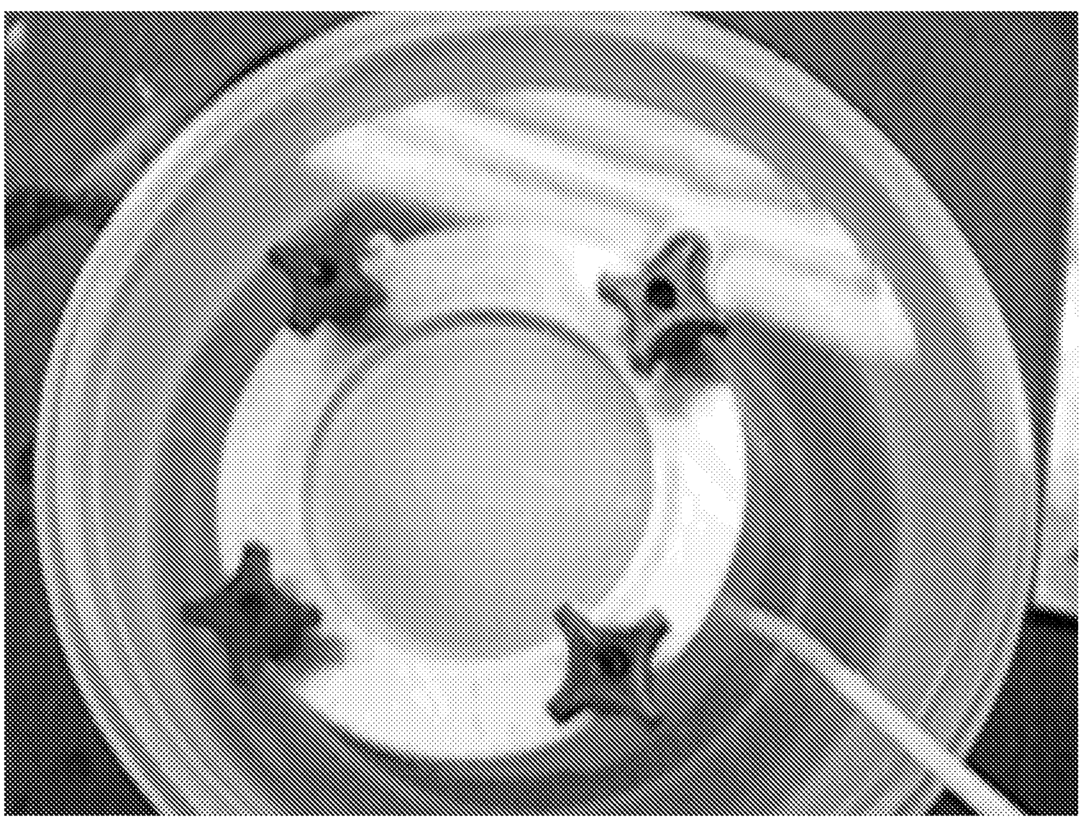


Image 6

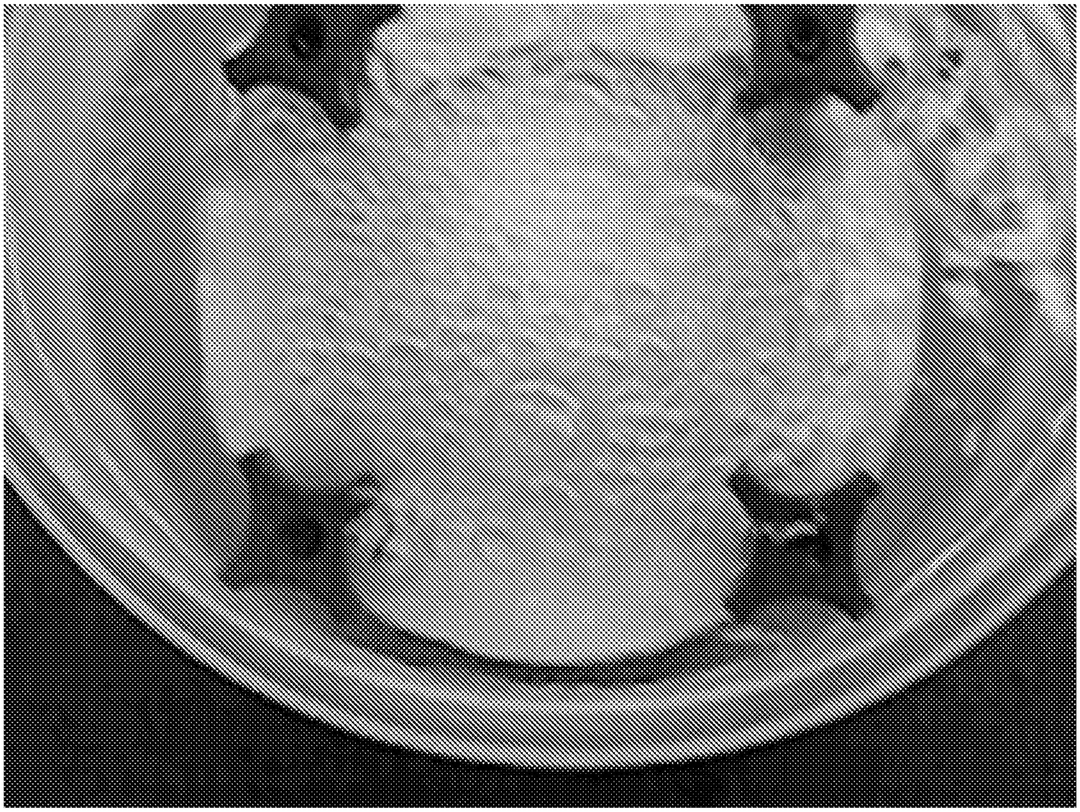


Image 7